OVARIAN STRUCTURE IN AN ABNORMAL PIGEON.

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In the course of my studies on the spermatogenesis and ovogenesis of the pigeon, a peculiar abnormal case came into notice which seems deserving of special mention because of its comparative isolation from the main subject, as well as for certain very interesting features it presents. The case was that of a dove which showed many unusual traits. Her actions and general appearance were very singular, and an anatomical examination revealed in the ovary a structural difference from the common type.

Whether the bird exhibited true arrhenoidy, — the female taking on the external characteristics of the male, — as described and named by Brandt ('89), is rather hard to determine, because the male and female doves are not to be distinguished ordinarily by means of their plumage. The abnormalities in the structure of the ovary, however, seem to be of much the same nature as he described for such conditions. Willey ('91) reports a somewhat similar case in the domestic duck.

The dove was a white bird with a faint yellowish ring around the back of her neck. She came into my possession through the kindness of Dr. Watasé, who raised her from a pair which he obtained originally in 1897 from the collection of Professor Whitman.

To Professor Whitman I am indebted for the following account of her genealogy. Very generously he has also supplied me largely with the material for the research upon the spermatogenesis of hybrids and of normal pigeons, in which I am at present engaged, and my obligations to him are very great.

The original ancestors of the dove in question were an ordinary ringdove (*Turtur risorius*) and a Vienna white (*Columba*

alba). Most authorities place the latter form in the same species as the former. The immediate progeny of the pair just mentioned was always brown in color, the male being generally of a slightly lighter shade than the female.

When these doves of the second generation bred they brought forth young which seemed usually to revert to the ancestral type; one member of the resulting pair was generally white, and the other brown. Curiously enough, out of some eighteen birds of this generation that I killed, the brown ones

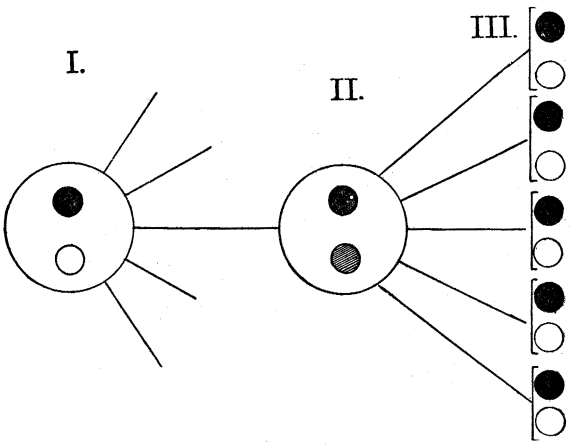

FIG. 1. — A diagram showing the lineage of the dove under discussion.

were invariably male and the white ones female. In one case where both of the young birds were brown, they were male, and in another where they were white, both were female.

Schematically, the lineage may be represented as in Fig. 1. The ancestral pair, one brown and one white, are represented by the two enclosed circles to the left. They give rise to a number of offspring, one pair of which is indicated by the two enclosed dark circles to the right of the first. These, breeding again, bring forth a large number of pairs, of which one member in each pair is usually white, the other one brown. The bird under discussion was of this last or third generation.

From the beginning she seemed to be abnormal. She was always of a very nervous disposition, and would fly wildly about when her cage was approached. While under observation she

was continually shivering and trembling. The same was true when a mate was placed in her cage. Although a number of different mates were placed with her at various times, she remained sterile. She was about two years old when killed and had never laid an egg.

In general appearance she was a very disreputable looking fowl. Her plumage was always ruffled and disordered, the large feathers of the tail being especially ragged and rough looking. Her voice resembled that of neither the ordinary male nor female, but was a sort of curious little crow, unlike anything I had ever heard. One eye was abnormal and gave her an odd, staring look.

Upon dissection the ovary from a general view seemed normal, but when sectioned and examined under the microscope many peculiarities of structure were discernible.

There were very few of what could be called normal eggs. The abnormalities were of several kinds, but a given type was generally more or less localized. The eggs varied in size, from small ones just visible under the low power of the microscope, to those measuring a fraction over a millimeter in diameter.

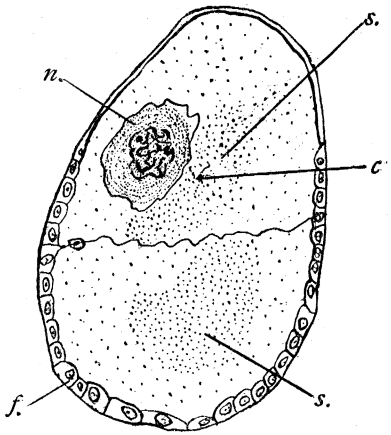

FIG. 2. — × 370. A double egg showing one nucleus and centrosome. The follicle cells are absent on one side. *c*, centrosome; *f*, follicle; *n*, nucleus; *s*, sphere.

The first peculiarity to strike the attention was the large number of double eggs; that is, two eggs lying within one follicle (Figs. 2, 3, and 4). Sometimes the follicle was absent wholly or in part, but in such cases the relation was yet so close as to be easily distinguishable. Often no intervening membrane was present between the two eggs, and the appearance was that of an egg cell containing two nuclei (Fig. 9). In places three and even four eggs were to be seen within a common follicle. In general, the multiple eggs seemed to lie in colonies; that is, where one case occurred, a number were

usually to be found in the same vicinity. As high as sixteen pairs, and two instances of triple eggs, were counted in the field at one time under a magnification of 110 diameters. This is, of course, an exceptional condition. Commonly four or five

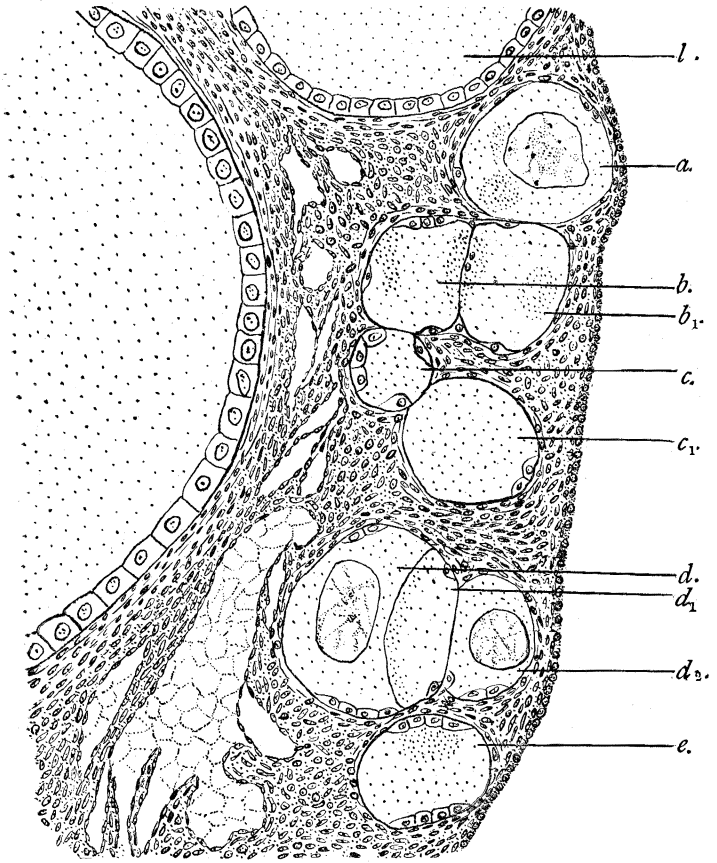

FIG. 3. — × 370. A section of part of the ovary. Every egg in the field is a multiple form; b, b_1, c, c_1, is a connected group of four; l, the edge of a large egg.

pairs are the most to be seen. Fig. 3 shows a section of a part of the ovary magnified 370 diameters. By following out the serial sections, the relations of the eggs represented in the figure were determined. Examining them in such a manner, a (Fig. 3) was found to be double; b and b_1 formed a double, likewise c and c_1; b and c were also connected as doubles. Thus

the group, b, b_1, c, c_1, really formed a cluster of four. The next group, d, d_1, d_2, formed a set of three, and the last egg, e, was double.

Almost all gradations of union between the two related eggs could be seen. In some cases there seemed to be but one mass of cytoplasm containing two nuclei (Fig. 9); in others a dividing membrane was present, but was incomplete. In still other examples there was a distinct membrane between the eggs, together with a few strands of connective tissue, with the follicle cells at the edges apparently creeping gradually in along the line of demarcation. Occasionally scattering follicle cells were found between the two eggs.

Most of the double forms were of small diameters. When large eggs were doubled they seemed to be in a state of degeneration. They contained large vacuoles, and, perhaps, in addition the cytoplasm was being consumed by phagocytic action. Fig. 4 represents four sections taken in order at varied places from one of the larger double eggs. At A (Fig. 4), in one of the eggs, the nucleus is shown. It is considerably shrunken. A faintly marked cell wall separating the two eggs is visible, and lining it on either side is the material of the so-called attraction sphere or yolk nucleus (s). The follicle cells at one edge (f) have lost their walls and form a sort of syncytial mass. At B (Fig. 4) the section shows the membrane which separates the two eggs as still visible. The nucleus of the other egg has come into view and is also much shrunken. At this point the sphere substance is seen to project out more toward the center of the upper egg, and in the center of this mass a clear space or vacuole (v) is visible. As the sections are passed over, this vacuole rapidly becomes larger and appears as at C and D respectively. In C there is no trace of a dividing cell wall, and the cytoplasm of the two cells mingles. In the sphere substance of the lower cell a second vacuole has made its appearance, and it gradually merges into the first, as seen in D.

The formation of vacuoles is very common, especially in the larger eggs, both single and double. In some of the eggs, indeed, most of the cytoplasm has disappeared, and only a large vacuole remains. Vacuolation begins invariably in the sphere

substance. Fig. 5 shows vacuolation just commencing in a large single egg.

The sphere substance in both single and double eggs may be found in various conditions. In many places it seems to be

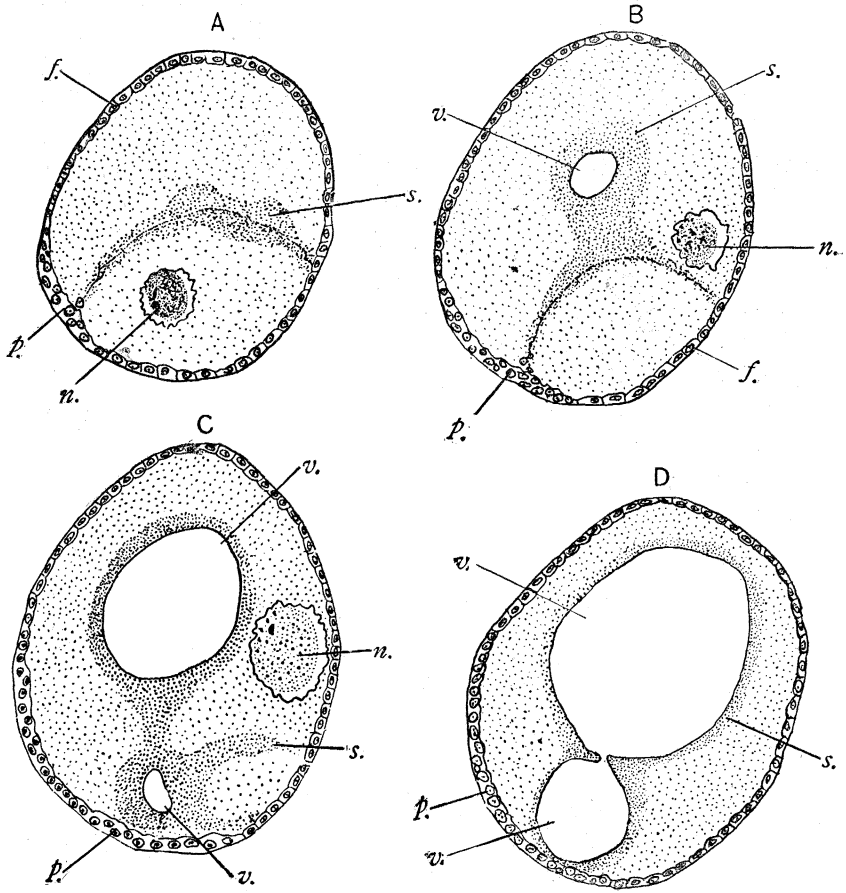

FIG. 4. — × 110. Four sections of a series from a large vacuolated double egg. *f*, follicle; *n*, nucleus; *p*, phagocytes; *s*, sphere; *v*, vacuole.

deteriorating. Besides being connected with the formation of vacuoles, it seems to play some rôle in the formation or dissolution, as the case may be, of the cell wall in double eggs. It is always in contact with the intervening cell membrane (Figs. 2 and 4, *s*). In the eggs of normal pigeons it remains in more or

less of a single mass, but here it may often be seen scattered throughout the cell in little clumps. These often seem to melt together, as it were, and form deeply staining liquid-like masses.

The nuclei in many of the eggs were shrunken, and showed an irregular wavy border. This was true of the larger eggs almost without exception. Fig. 5 shows a common form. The nuclear material is collected into a granular mass in the center. Irregular rods and granules of chromatin material can be dis-

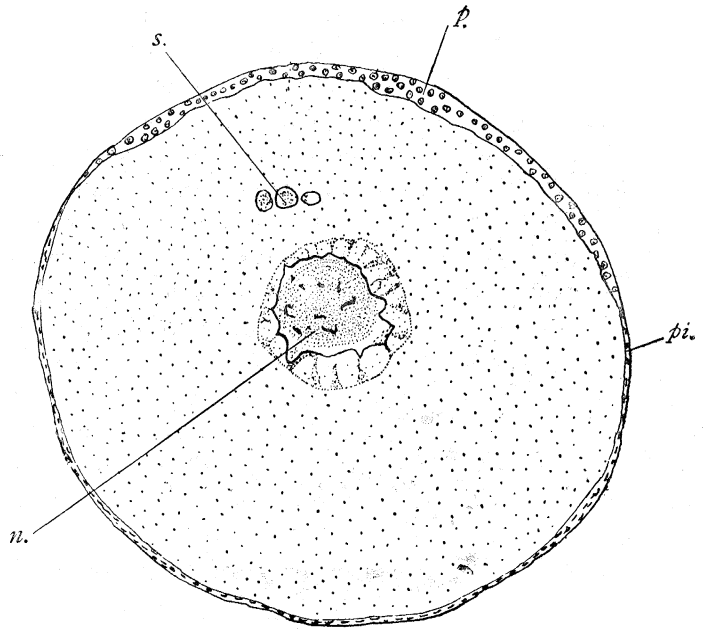

FIG. 5. — × 78. A large egg showing phagocytes (*p*) at the periphery on one side, and pigment (*pi*) on the other. The nucleus (*n*) is shrunken and the sphere (*s*) forming vacuoles.

tinguished. The nuclear membrane is collapsed and shrunken, and surrounded by a lighter area of cytoplasm, which has the appearance of streaming or being drawn toward the nucleus. This aspect is due probably to the contraction of the nucleus, which carries in the surrounding cytoplasm as it recedes. In other cases the nuclei seemed to be in the last stages of degeneration, and were simply clear areas crossed by colorless feathery strands (Fig. 8).

Nucleoli might or might not be present. In the normal egg

they are very characteristic deeply staining round bodies. In the abnormal form, if present, they were generally small and irregular. Occasionally they appeared as pale, uneven masses, which seemed to be disintegrating.

Centrosomes were frequently present, and were always closely connected with the sphere substance. In none of the eggs was mitotic division found in progress. Fig. 6 shows two centrosomes (*c*) lying side by side in the midst of a system of radiating fibers. The sphere substance is collected for the most part into two more or less crescentic areas at either side. The centrosomes proper were surrounded each by a small clear space, and then by a darker area of what appeared to be sphere substance. Outside this latter region came the system of fibers. The nucleus had the characteristic shrunken appearance. Another egg was found in which two centrosomes, each surrounded by a mass of sphere substance, were lying on either side of the nucleus, but no trace of a spindle or other preparation for mitosis was visible. In Fig. 2 a single centrosome (*c*) is seen.

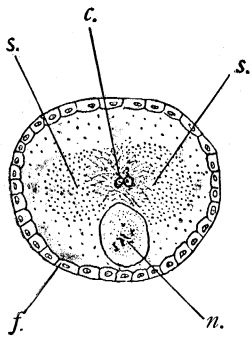

FIG. 6. — × 135. An egg showing two centrosomes (*c*). *f*, follicle; *n*, nucleus; *s*, sphere.

Another common phenomenon shown by many of the eggs was the destruction of the cytoplasm by means of phagocytes or eating cells. There were two methods of consumption by such cells. Either they wandered into the interior of the cell and gradually devoured the material about them, or they multiplied around the periphery of the egg and gradually crowded in upon the cytoplasm, consuming it as they approached the center. The first method was rare, being seen in only three or four eggs, and then to a limited extent. This is unlike the cases described by Brandt ('89) and Willey ('91), where this type of yolk resorption seemed to be common (*cf.* Brandt, '89, Figs. 5–8; also Willey, '91, Figs. 1 and 2).

The second process was the usual one. There were scarcely any of the larger eggs that did not display it to a greater or less

extent. Fig. 7 shows a somewhat advanced stage. The section is to one side of the center of the egg. The remaining cytoplasmic material (*cy*) exhibits a very ragged, irregular border, surrounded by numerous nuclei lying in one continuous mass of cytoplasm. These nuclei are the nuclei of the erstwhile follicle cells, whose walls have disappeared, and the cell contents flown together to form a syncytium. Brandt pictures a very similar phenomenon in his paper (*cf.* Brandt, '**89**, Figs. 4, 13, and 16).

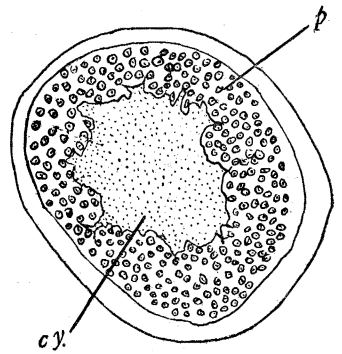

FIG. 7. — × 110. An egg in process of resorption by means of the transformed follicle cells. *p*, phagocytes; *cy*, cytoplasm.

In regard to the origin of the phagocytes in such cases there is some difference of opinion. Brandt ('**89**) describes the occurrence as due to the wandering in of follicle cells, while Willey ('**91**) maintains that in the case he studied, the cells were transformed stroma cells. Ruge ('**89**) says that, in such cases of resorption in the amphibian ovary, both the follicle and stroma cells, or white blood corpuscles, play a rôle.

In the present instance the process is carried on almost wholly by the transformed follicle cells. In a very few cases where eggs lay in the neighborhood of the larger blood vessels, cells from the outside seemed to be wandering through the follicular layer; but they could never be traced into the interior of the egg. At that part of the egg periphery not yet attacked by the eating cells, normally, the follicle is visible as a comparatively thin layer of cells, each with a distinct membrane. When about to undergo the transformation into phagocytes they enlarge, the cytoplasm shows a different micro-chemical reaction, and the cell boundaries become less distinct. At a little later period many of the cells are seen undergoing karyokinetic division. After karyokinesis, they loose their walls and are ready to take on the new function of resorption.

Often, as is shown in Fig. 5, the new cells (*p*) were confined to one side of the egg, and resorption occurred only from that

side. On the opposite side, in the figure, the follicular cells have entirely disappeared, leaving behind a more or less distinct layer of pigment (*pi*). Under such conditions the phagocytes continue to advance until they pass entirely across the egg, devouring the cytoplasm as they go.

Where the cell contents yet remained intact in the larger eggs, it always had a peculiar, finely granular, homogeneous appearance, very different from that of the same sized egg of a normal bird. In the latter egg the cytoplasm always has a reticulated appearance, and grows much denser as it approaches the periphery. Oil droplets of varying size are scattered plentifully throughout it. No trace of such structures was evident in the eggs under discussion.

The question arises whether the doubling of eggs is really a division of the original primordial ovum, or whether it may not be a fusion of two cells, due to the general deterioration manifested everywhere throughout the ovary. I had scarcely completed the observations here recorded, when I came upon the paper of Stoeckel ('99), and found in his plates certain figures which agreed almost identically with some of my own preparations. His drawings were made from sections of the ovary of a woman, and show the same curious doubling of cells and nuclei here mentioned (*cf.* Stoeckel, '99, Figs. 2–15). He is inclined to regard the doubling as due to a division of the primordial egg. He also records the case of an embryonic infant in which such double eggs and nuclei were very common and apparently perfectly natural phenomena. In regard to the child he says that doubling is unquestionably due to an amitotic division of the egg, or, in his own words: "Diese Befunde zeigen zunächst, dass eine direkte Ei- und Follikeltheilung im fötalen Ovarium sicher stattfindet." (Stoeckel, '99, p. 370.)

His first case, however, was that of an adult, a nullipara, twenty-nine years of age. From the facts he mentions in regard to her, it does not seem improbable that the phenomena of double egg formation, as in the dove, was a pathological one. Her history showed that she was of weak constitution and chlorotic.

As to the doubling of eggs in the dove ovary, I am inclined

to believe that such conditions are brought about by both division and fusion. The greatest amount of doubling was seen in the very young ova, and, I think, resulted generally from division. Although no actual division was observed, yet the general appearance of the cytoplasm, and the plump, full nuclei of the young double eggs, exhibited none of the signs of deterioration one would expect if a fusion of two eggs, preparatory to going to pieces, were in progress. Some of the smaller eggs are doubtful, however, and the indications are that there may be fusion instead of division. There can be but little doubt that a form, such as is shown in Fig. 8, is the result of a fusion. By following out the serial sections, it was found to be really two ova with a single nucleus which resulted from the fusion of the two original nuclei. The nucleus thus formed seemed to be almost completely degenerated, and was wholly devoid of

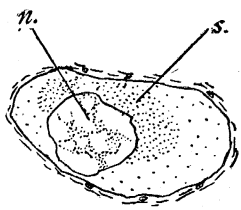

FIG. 8. — × 525. A double egg formed by fusion. The two nuclei have united to form one. The follicle has disappeared. *n*, nucleus; *s*, sphere.

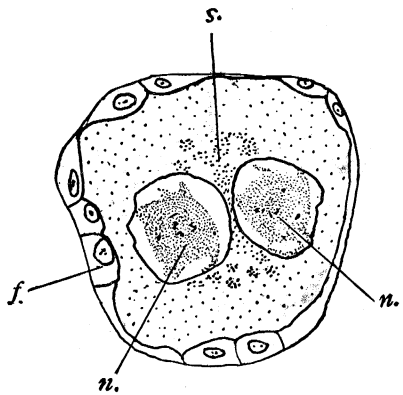

FIG. 9.

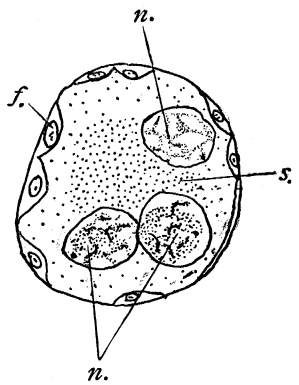

FIG. 10.

FIG. 9. — × 525. A double nucleated cell. *f*, follicle; *n*, nucleus; *s*, sphere.
FIG. 10. — × 525. A triple nucleated cell.

contents beyond a few rough, straggling threads of poorly staining material. The follicle had disappeared. Figs. 9 and 10 are two rather doubtful cases. In each the follicle was represented by a few large cells irregularly disposed, but whether

the follicle was disappearing or forming could not be determined. In Fig. 9 the nuclei are somewhat shrunken and consist principally of a granular mass. The sphere substance, which, as was above mentioned, seemed always in some way connected with the formation or disappearanee of the separating membrane, lies between the nuclei and is broken up into granular clumps. In Fig. 10, an egg with three nuclei, the sphere seems to be perfectly normal. Two of the nuclei lie in contact and seem to have recently divided. The third lies apart and contains only a few feathery strands of material, which seems to be breaking up and disappearing.

In some of the larger ova, as in Fig. 4, where vacuoles have appeared, or where cytoplasm is being devoured by the transformed follicle cells, the process is probably one of fusion preparatory to disintegration. It is not improbable that in some instances the two cells were a product of the same division, and after lying side by side and passing through a period of growth, they again fused into one mass as degeneration set in.

Regarding the cause of such abnormalities as have been described, but little can be said. Whether the abnormal structure of the ovary is due to the derangement of other organs of the body, or whether the accompanying bodily peculiarities are caused by the unnatural ovary, cannot be definitely determined. One would, however, without evidence to the contrary, naturally incline towards the latter view. The far-reaching effect of a change in the reproductive organs, especially in case of injury or removal, is well known to all. Yet it is not impossible that some stimulus from outside the ovary, perhaps of a chemical nature, could act upon it secondarily and produce the modifications described. The blood would provide a ready means for the conveyance of any chemical substance that might be formed elsewhere in the body. Cases are not unknown where division of the unfertilized ovum has been brought about by means of chemical stimulus. Interesting suggestions arise, too, that these phenomena might in some way be connected with hybridization, and, indeed, certain facts have come to light recently in my study of hybrid material, which render this idea by no

means unplausible. The subject is at least deserving of very careful consideration.

The principal facts adduced in this paper are briefly as follows:

(1) A dove, the offspring of a Vienna white (*Columba alba*) and a common ringdove (*Turtur risorius*), remarkable for her unusual appearance and manner, was found, upon dissection, to have an abnormal ovary;

(2) The ovary contained many double eggs, that is, two or more eggs lay within one follicle; they might or might not be separated by a distinct membrane;

(3) Nearly all of the larger eggs were vacuolated;

(4) The vacuoles always appeared in connection with the substance of the attraction sphere;

(5) The membrane separating double eggs also seemed to be related in some way to the sphere;

(6) The nuclei, especially of the larger eggs, were generally shrunken and seemed to be degenerating;

(7) Nucleoli were frequently present, but in many cases were indistinct and irregular in outline;

(8) Centrosomes were frequently present, but mitotic division of the eggs was never observed;

(9) Many of the eggs, especially the larger ones, were undergoing resorption by means of phagocytes, which in the vast majority of cases, if not all, were transformed follicle cells;

(10) Instances were found where the follicle cells had disappeared along part of the periphery of the egg, leaving behind a deposit of pigment. In such cases one side of the egg was usually undergoing dissolution through the activity of the phagocytes;

(11) The doubling of eggs seemed to be due in most of the smaller eggs to (*a*) a division of the primordial cell, and in the larger ones to (*b*) a fusion of contiguous cells;

(12) The cause of such abnormalities is not known. Possibly some connection with hybridization may be shown later.

HULL ZOÖLOGICAL LABORATORY,
March 10, 1899.

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